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How Can Big Data Analytics Improve Outbound Logistics in The UK Retail Sector? A Qualitative Study

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Abstract

Purpose - The purpose of this study is to explore how big data analytics (BDA) as a potential IT innovation can facilitate the retail logistics supply chain from the perspective of outbound logistics operations in the United Kingdom. Our goal was to better understand how BDA can be integrated to streamline supply chains and logistical networks by using the technology, organisational, and environmental model.

Design/methodology/approach – The authors applied existing theoretical foundations for theory building based on semi-structured interviews with fifteen (15) supply chain and logistics managers.

Findings – The perceived benefits of using BDA in outbound retail logistics comprised the strongest predictor amongst technological, organisational, and environmental issues, followed by top management support. A framework was proposed for the adoption of BDA in retail logistics. Contextual concepts from previous literature have helped us understand how environmental changes impact BDA decision-making, as such: (i) SC maturity levels and connectivity affect BDA utilisation, (ii) connected SCs improve data accessibility and information exchange, (iii) the benefits of BDAs also affect adoption and (iv) outsourcing complex tasks to experts allows companies to focus on core businesses instead of investing in IT infrastructure.

Research limitations/implications – Outside the key findings listed, this study shows that there is no one-size-fits-it-all approach for use within all organisational settings. The proposed framework reveals that the perceived benefit of BDA is non-transferrable and requires top-level management support for successful implementation.

Originality/value – The existing literature focuses on the approaches to applying big data analytics in supply chain and logistics but fails to present a deep dive into retail outbound logistics activity. This study addresses the "how" and proposes a social-inclusive framework for a technology-enabled topic.

Keywords: Supply Chain Analytics, Big Data Analytics, Outbound logistics, Retail Supply Chain Management, TOE framework

1. Introduction

The application of big data analytics (BDA) as a knowledge tool has shown immense potential to transform supply chain and logistics management operations (Wang *et al.*, 2016). In recent years, the amount of data generated by businesses has exploded, and this trend is expected to continue. As a result, many organisations are turning to big data analytics in order to make sense of this vast amount of information and gain insights that can help them improve their operations (Angappa *et al.*, 2017; Akter *et al.*, 2020). Within the supply chain context, BDA has shown promise to revolutionise the industry, offering novel insights and efficiencies through the analysis of large and complex data sets, as evidenced in recent literature (Behl *et al.*, 2022; Bhatti *et al.*, 2022; Gopal *et al.*, 2022; Jaouadi, 2022). BDA approaches have rapidly emerged as a medium for gaining competitive advantage in organisations today (Tan *et al.*, 2015; Akter and Wamba, 2016; Davenport and Harris, 2017; Tiwari, Wee and Daryanto, 2018; Akter *et al.*, 2020). Its impact has sparked increased interest not only in the academic literature, but within industry as use for decision-making in nearly all sectors of human endeavour (Akter *et al.*, 2021; Bag, Gupta and Kumar, 2021; Fatorachian and Kazemi, 2021; Sultana *et al.*, 2021). In recent times, BDA has received increased interest in its application in supply chain and logistics management (Wang *et al.*, 2016; Lai, Sun and Ren, 2018; Wamba *et al.*, 2018). The application of BDA has addressed critical challenges encountered in organisations, including enhancing operational efficiency (Chang *et al.*, 2021), aligning operations with business strategy (Xie *et al.*, 2022) and enhancing supply chain processes (Fosso Wamba *et al.*, 2018). The logistics processes in the supply chain have had a profound impact from BDA in recent times, resolving existing challenges and proposing solutions to problems, such as route optimisation (Hopkins and Hawking, 2018), demand forecasting (Seyedan and Mafakheri, 2020) and consumer behaviour analytics (Lai, Sun and Ren, 2018). The literature relating to the strategic approaches to supply chain decision-making for BDA in supply chain and logistics management (SCLM) is growing in popularity and is a trend that is likely to continue. Besides, the specific logistics function within a supply chain comprises a vital part of the overall supply chain management process. Outbound logistics refers to the movement of goods from a company's warehouses to its customers and constitutes a crucial part of any supply chain. In order to operate efficiently, outbound logistics operations must be able to quickly and accurately process orders, route shipments, and track the movement of goods (Dubey *et al.*, 2018). However, managing these activities can be complex and time-consuming, especially for large organizations with multiple warehouses and a large number of customers.

The use of big data analytics in outbound logistics operations can provide several key benefits and its application in logistics is prevalent (Chen, Preston and Swink, 2015; Zhong *et al.*, 2015; Wang *et al.*, 2016). For example, it can help organisations better understand their customers' needs and preferences (Zhan *et al.*, 2018), allowing them to tailor their products and services to meet those needs. Additionally, big data analytics can be used to improve the accuracy and efficiency of order processing, routing, and tracking, reducing the time and cost associated with these activities. Despite its popularity as an innovative technology, the potential of big data in many industries remains untapped (Sheng *et al.*, 2021). Therefore, we argue that the research field could benefit from more evidence supporting the use of BDA in supply chain operations (Wamba *et al.*, 2015; Nguyen *et al.*, 2018; Maheshwari, Gautam and Jaggi, 2021). However, there is a scant literature in the intersection of BDA and logistics management (Lai, Sun and Ren, 2018; Pawar and Paluri, 2022). For this reason, the focus of this study is on the logistics sub-area of supply chain management operations to see how BDA impacts supply chain operations and its potential to enhance supply chain resilience.

Unstructured data is a stream of raw facts representing an event occurring within an organisation or in the physical environment. The data processing capabilities of BDA as a knowledge generation tool can help increase information accessibility, reduce information asymmetry, reduce costs, and save time whilst improving overall business efficiency. According to recent research, BDA can help retail logistics operations improve their ROI (Benoit, Lessmann and Verbeke, 2020), improve marketing accuracy (Xu, Frankwick and Ramirez, 2016; Janssen, van der Voort and Wahyudi, 2017; Essien and Petrounias, 2022). Some studies have shown the business value of BDA using individual cases or expert knowledge with limited theoretical understanding (Maheshwari, Gautam and Jaggi, 2021). For this reason, the resources required to develop a BDA technique and the mechanisms by which BDA may generate business value are less studied. There is also a lack of research demonstrating the impact of BDA on retail logistics operations, as well as novel theories and emerging practises in this domain (Awan *et al.*, 2021). The importance of this study cannot be overstated, as most research in this area focuses on operations in general rather than retail logistics. Besides, the UK is heavily reliant on imported fruits and vegetables, with up to 83 percent of fresh fruit and 44 percent of fresh vegetables coming from abroad (DEFRA, 2018).

Recent research shows an increase in both industry and practise research interest in BDA (Maheshwari, Gautam and Jaggi, 2021). However, despite the hype as evidenced in the literature, there is a disconnect between the two. As a result, practice/industry and academic BDA use is fragmented and rhetorical. The present study proposes a framework for understanding the importance of BDA in logistics supply chain operations, as well as the potential benefits. A UK logistics firm is used as a case study to collect qualitative data on the BDA in retail logistics operations. From the foregoing, this study focuses on outbound logistics, which involves moving goods or products from the firm to customers, allowing researchers to learn more about firms' logistical operations beyond the confines of internal supply chain processes. We argue that this understanding can help to better understand how BDA, as a knowledge tool, can be used to improve logistical operations on an organisational, individual, or social level.

Therefore, this study will address the following research question:

RQ1: How can BDA, as a knowledge tool, be used to improve outbound logistical operations?

RQ2: What are the key challenges and potential benefits of using big data analytics in outbound logistics operations in the retail industry?

Given the above, it appears logical to assume that the TOE theory (Depietro, Wiarda and Fleischer, 1990) is best suited to explain this research phenomenon. Other theories that can be considered include the technology task-fit model (DeLone and McLean, 1999), institutional theory (Scott, 2005), actor network theory (Law, 1992), socio-materiality (Orlikowski and Scott, 2008), and sociotechnical theory (Mumford, 2006). Our study has adopted the TOE framework for three key reasons. First, the TOE framework offers a comprehensive perspective on the relationship between technology, organisational structure, and environmental factors (Al-Dmour *et al.*, 2021; Pillai *et al.*, 2022). This is particularly relevant for our study, as we are examining the use of big data analytics in outbound logistics operations in the retail industry. In this context, it is important to consider not only the technology itself, but also the organisational structures and processes that support its implementation, as well as the broader environmental factors that may impact its adoption and use. Secondly, the TOE framework allows us to consider the dynamics of technology adoption and implementation in organisations. This is crucial to our study, given the particular interest in understanding the challenges and potential benefits of using big data analytics in outbound logistics operations. By examining the interplay between technology, organisational structure, and environmental factors, it is possible to identify potential barriers to the adoption of big data analytics, and suggest strategies for overcoming these challenges. Thirdly, the TOE framework is grounded in empirical research, with a strong emphasis on case studies and real-world examples (Choi and Siqin, 2022). Given the objectives of this particular study, which seeks to provide practical insights and recommendations to organisations considering the use of big data analytics in retail logistical operations. The TOE framework's focus on empirical research allows us to draw on a wide range of relevant examples and case studies to support our findings and conclusions.

However, TOE aligns with our goal to better understand how a technology (e.g., BDA) can help individuals and organisations achieve their goals, as well as how well it integrates with a user's needs, skill set, and current tasks. To complement our theoretical proposal, we propose a field study involving cross-sectional semi-structured interviews with logistics managers in the United Kingdom.

The specific contributions of this study are summarised as follows:

1. To the best of the authors' knowledge, this is the first study that applies an instantiation of the TOE model to propose a social-inclusive framework for understanding how BDA impacts outbound logistics in the retail sector.
2. This is the first empirical investigation of BDA adoption we have encountered, specifically in supply chain and logistics management.
3. Contrary to previous research, we view contextual concepts as moderators that can help us understand how environmental changes affect BDA decision-making. We were able to determine the impact of SC and logistical connectivity on BDA utilisation by comparing SC maturity levels.

The remainder of this paper is structured as follows. Section 2 presents a review of relevant literature, including the impact of BDA in logistics. Section 3 discusses the research methodology, which incorporates semi-structured interviews. In Section 4, the results of the study are analytically presented, supported by the data analysis approach, as well as critically discussing the results against the theoretical underpinnings, focusing on the research questions, and highlighting the practical, managerial, and theoretical implications of the study. The paper is concluded in Section 5 in addition to proposing future research.

2. Literature Review

The combination of globalisation, increased competition, higher consumer expectations, shortened product life cycles and the potential to decrease production time and cost have led to an increased focus on supply chains by top management (Simchi-Levi *et al.*, 2008). Accordingly, a supply chain is typically described as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, finances, and/or information from a source to a customer" (Mentzer *et al.*, 2001, p.4).

2.1 Logistics and Supply Chain Management

A key definition of a supply chain highlights its characteristics and functions, comprising all stages involved, directly or indirectly, in fulfilling a customer request. Hence, as a concept, supply chain management encompasses the flow of materials and information within a supply chain (internal supply chain), or between companies (an external supply chain). In the UK, the grocery retailer's supply chain comprises upstream and downstream parties across its supply chain. In this given supply chain, the downstream consumers consist only of the customers, as retailers are the last members of the supply chain. However, upstream supply chains include the wholesalers and suppliers for smaller or independent retailers and only the supplier for larger retailers or supermarket chains as depicted in Figure 1.

The significance of logistics and supply chain management in global business operations is well-known and cannot be exaggerated (Wang *et al.*, 2016; Angappa *et al.*, 2017; Lai, Sun and Ren, 2018). It plays a fundamental part in providing and maintaining business competitive advantage (Chen, Chiang and Storey, 2012). The role of logistics in the overall business process is evidenced via "completing the mission" by transporting materials and products using one (or more) transport modes – land, water, and air. Some metrics have been proposed to measure the supply chain performance by relating the logistics component, which enrich the supply chain research. For instance, the cost efficiency and customer-service pointers (Tummala, Phillips and Johnson, 2006), resource efficiency (Narasimhan and Das, 1999; Matopoulos, Barros and van der Vorst, 2015; Shuaib *et al.*, 2015), supply chain flexibility and agility (Vickery, Calantone and Dröge, 1999; Gupta *et al.*, 2019) and, more recently, resilience and robustness (Brandon-Jones *et al.*, 2014; Papadopoulos *et al.*, 2017). As can be seen from the figure, the "rather simplified" depiction of a hypothetical retailer comprises several parties, which are sometimes distributed in various geographical locations globally. This implies some high degree of complexity in the supply chain operations, such that the disruption to a single supplier or upstream party can result in sometimes cataclysmic effects on the business operations. In fact, the stock price of a public retailer has been shown to decline by an average of 9 per cent within a 24-hour period of a supply chain problem being disclosed, with an additional 9 per cent drop recorded over the next 90 days (Randall *et al.*, 2011). The logistics operations in retail supply chains face disruptions due to a range of factors, as listed above (e.g., COVID-19).

However, there are some critical issues encountered by the logistics and supply chain management, for instance, inefficiencies and waste in supply chains (Wang *et al.*, 2016), environmental and sustainability-related challenges (Abbasi and Nilsson, 2012; Mangla *et al.*, 2019; Sun and Shi, 2021). Besides, recent disruptions due to COVID-19 and other happenings, order delays, ever-increasing consumer buying power, and information irregularity can all negatively affect the business operations. Therefore, in face of these significant transformations, globalisation, and increasing uncertainty, it is particularly important for firms to leverage the resources and knowledge of their suppliers to integrate both internal and external data sources to improve operational performance and customer satisfaction (Grover *et al.*, 2018). To summarise, there is a strong need for the application of robust and efficient approaches – driven by technology – for firms to improve the visibility, flexibility, and efficiency of logistics operations.

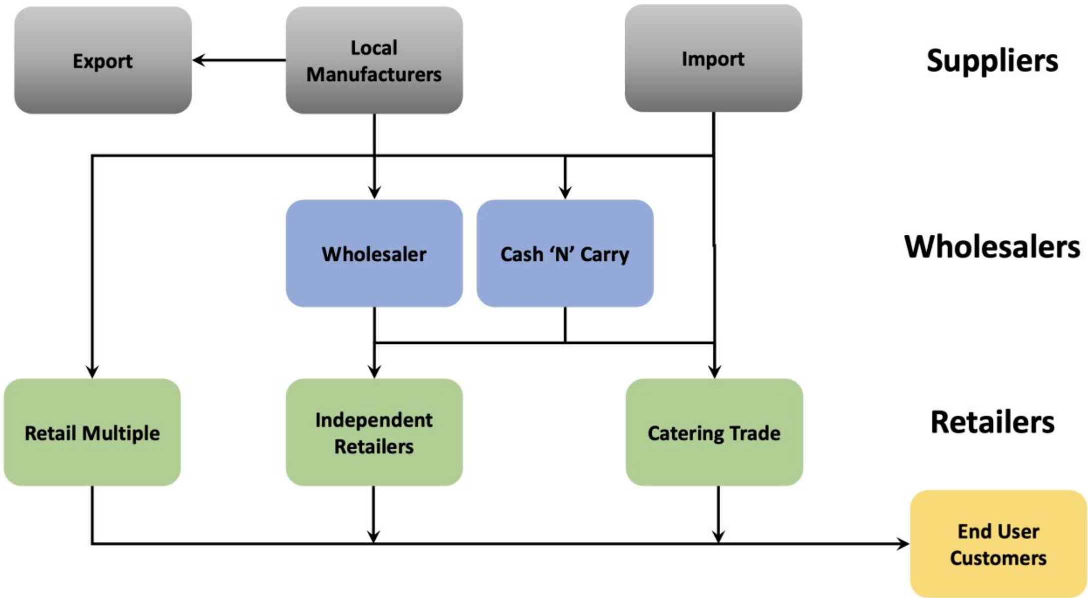


Figure 1 – Simplified diagram of a UK retail supply chain (Adapted from Waters (2021))

2.2 Big Data Analytics

Technological advancement, the internet, and mobile technology have resulted in a massive amount of data created and captured at a high velocity (Kauffman, Srivastava and Vayghan, 2012). Recent forecasts about the total amount of data generated stands at 180 Zettabytes (10^{21}) by 2025 (Holst, 2021). To put this in another context, the world is jointly outputting 2.5 quintillion bytes (10^{9}) of data daily, with each human producing about 1.7 Megabytes of data per second (Reinsel, Gantz and Rydning, 2017). Obviously, the world is fast becoming an assortment of data generating processes, with all activities creating, copying, or transmitting data. As an example, when streaming a song online, data about the time, location, and platform are generated, transmitted and/or stored somewhere. If we also consider our fitness/activity wearable devices, (smart watches, etc.) data are being produced about running/walking speed, heart rate, etc. It is quite easy to expand this list to every aspect of our daily lives – focusing on interactions with our smartphones. These smartphones act as sensors (same as IoT devices) that measure, collect and transmit these data, which are typically analysed to enhance service provision and delivery, shared with other organisations, etc., all resulting in a continuous value chain of data generation processes. Concurrently, technological advancement has resulted in the proliferation of analytical tools, algorithms, and models for analysing these structured and unstructured/big (and extreme) data – birthing a new field known as big data analytics (BDA), which is a subset of AI. It is important to mention that BDA represents a subset of AI that concerns the complex process of examining big data to uncover information (Subramaniyan *et al.*, 2021). Simply put, BDA often refers to the complex process of analysing big data to extract knowledge in the form of hidden patterns, correlations, etc. (LaValle *et al.*, 2011).

On a business side, organisations daily encounter, process, or store various forms of data, which sometimes contain user logs, customer transaction records, and customer-generated content (Chen, Chiang and Storey, 2012). The vastness and relevance of these data is transforming BDA into a vital tool for businesses such that its research – both scholarly and in practice – interest is consistently on the rise (Kazancoglu *et al.*, 2021). In the literature, there are many studies that have discussed and analysed the opportunities brought about by BDA, for instance, Hamilton and Sodeman (2020), Buganza et al., (2015), Kazancoglu et al., (2021) and George and Lin (2017). Given the 3Vs – high-volume, high-velocity, and high-variety – characteristics of big data (Laney, 2001), generated via multiple channels, BDA is proposed for the analysis and description of the vastness and complexity of big data, which is too much for conventional business intelligence approaches. Formally, BDA is defined as "a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery and/or analysis" (Ji *et al.*, 2012). Interestingly, BDA has been characterised to two broad perspectives: big data and business analytics (Wang *et al.*, 2016; Saleem *et al.*, 2020; Narwane *et al.*, 2021). Big data provides the information and technological basis for analytical activities (Mangla *et al.*, 2020), while the analytical component offers organizations with valuable business insights, which can play a vital part in providing support for the decision-making process, if used appropriately and effectively (Inamdar *et al.*, 2020; Özemre and Kabadurmus, 2020). Investment in BDA is a prerequisite to leveraging the vast data generated and these investments include the underlying BDA infrastructure, the proper management and human capital/personnel expertise (Wamba *et al.*, 2017; Saleem *et al.*, 2020; Narwane *et al.*, 2021). In other words, in addition to the tangible (financial and physical resources) and intangible resources (organizational culture and learning), employee expertise and technical capabilities (employee's knowledge and skills) are also compulsory in the entire BDA (Gupta and George, 2016; Wang *et al.*, 2021).

2.3 Technology-organisational-environment (TOE) model and logistics in supply chain

The adoption of BDA for logistics and supply chain management can be described as an innovative way of performing business activities. Rogers (2002) showed that the *diffusion of innovation* (DOI) theory, which is grounded in sociology, is used to examine the interaction of an innovation and the mechanism of how it diffuses through a system/domain. When examining the rate of innovation acceptance, Rogers (2003) posited five innovation characteristics (relative advantage, compatibility, complexity, trialability, and observability), which play a significant role in the innovation adoption process. Regarding innovation and IT diffusion, researchers have – over the years – contributed to enriching the research portfolio of innovation and technological adoption and acceptance at both theoretical and organisational levels. Theoretical developments in this field include the theory of reasoned action (Ajzen and Fishbein, 1975), technology acceptance model (Davis, 1989), motivational model (Davis, Bagozzi and Warshaw, 1992), theory of planned behaviour (Ajzen, 1991), and social cognitive theory (Bandura, 1989) are universally adopted for the purpose of providing explanations to the acceptance of a technology by an individual. On the organizational level, the innovation diffusion theory (Rogers, 2002) and the TOE framework (Depietro, Wiarda and Fleischer, 1990) are the frequently adopted theories for identifying the internal and external factors affecting technological innovations in organizations (Alshamaila, Papagiannidis and Li, 2013). The significant difference between the TOE framework and Roger's model is that the TOE framework introduces a new factor – environmental context – which provides a better understanding of the decision mechanism.

2.4 Conceptual Model

This paper views BDA as a strategic resource and a technological innovation (Kwon et al., 2014), and thus theorise the diffusion of innovation (DOI) (Rogers, 2003) and the

TOE frameworks (Tornatzky and Fleischer, 1990). Based on extensive research, we identified and categorised into four categories the numerous factors influencing BDA adoption for improving outbound logistics. Contexts include technology, organisation, environment, and SC and logistical traits. We developed the conceptual model depicted in Figure 1 using the insights gained from the TOE framework and our research context of SC and logistical management (see Figure 2).

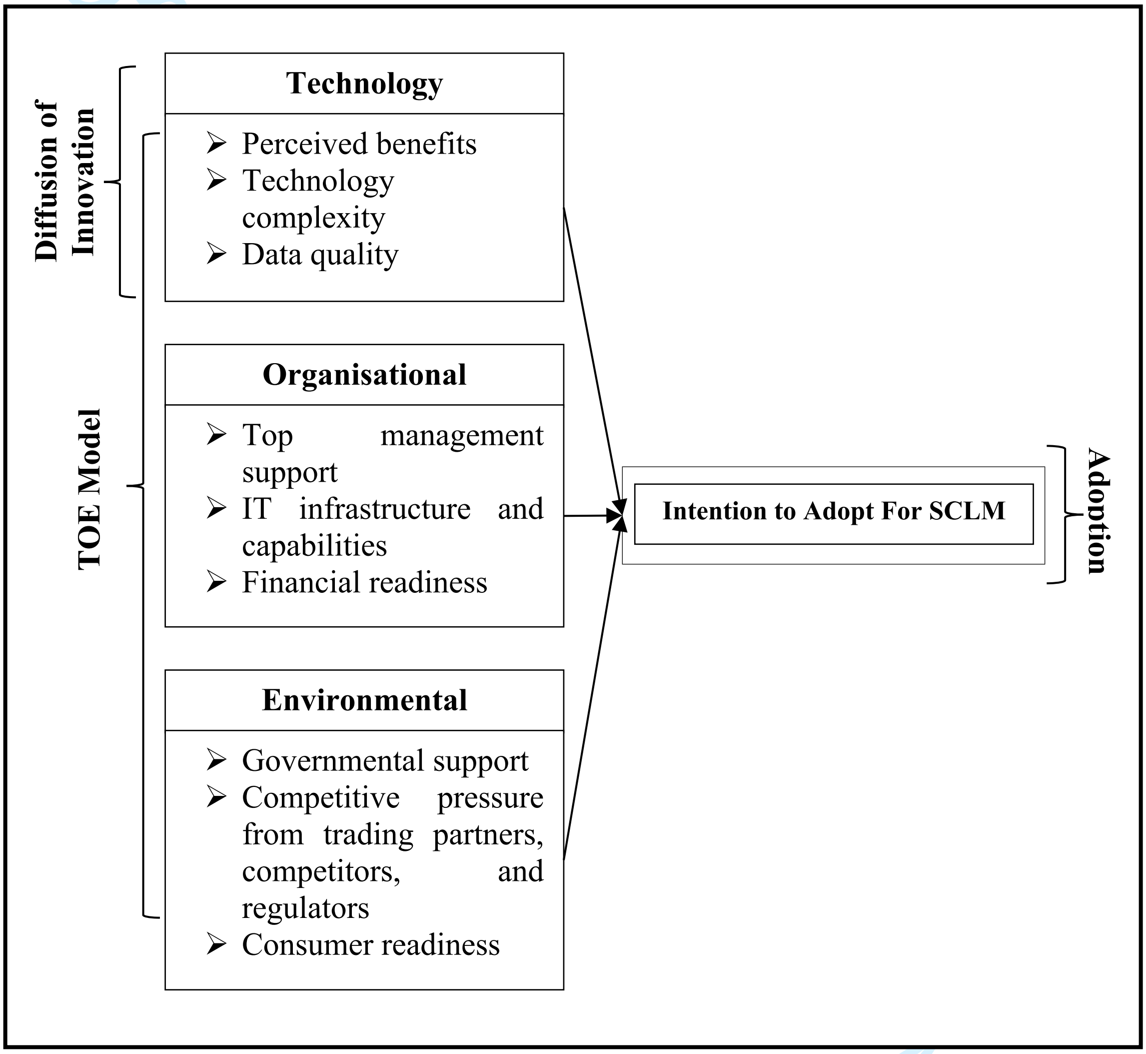


Figure 2 – Conceptual Model of BDA Adoption for Supply Chain and Logistics Improvement

Technology Context

The technological context focuses on the attributes of the technology that may have a positive or negative effect on the decision to adopt it (Maduku et al., 2016). Drawing on previous literature, our primary BDA adoption drivers were perceived benefits (Gunasekaran et al., 2017) and technological complexity (Maduku, 2016). Hence, **perceived benefits, technology complexity, and data quality** were the three most influential determinants of innovation adoption in the technology context. Perceived benefits describe the extent to which BDA technology can benefit an organisation. BDA can provide SC with improved prediction and management of SC risks, stronger partnerships, and a reduction in SC waste (Gunasekaran et al., 2017). Moreover, BDA enables organisations to fully utilise internal and external data to analyse industry shifts and trends (Cao et al., 2009). Managers will be more likely to adopt BDA once they recognise its unique benefits.

Technological complexity refers to how challenging it is for an organisation to comprehend and implement BDA technology. BD is not a meaningless concept; it encourages companies to act to gain insightful knowledge. Companies must, for instance, train BDA specialists, finance BDA operations, and promote BDA among inter-organizational functions. Incompatibility with existing IT systems, flexibility of IT infrastructure, data processing capability, high investment, and maintenance costs of establishing BDA and related IS, and security issues of vital business data of SC flows were identified as barriers to the implementation of BDA for logistical improvement.

In this paper, data quality refers to the degree to which data are readily accessible, consistent, and complete and in the BD data mining or text mining, data processing, visualisation, and aggregation (Wang and Hajli, 2017). The availability of diverse data is crucial to the BD success of a company. Two factors determine the quality of data: consistency and completeness (Hartnett et al., 1988; Kwon et al., 2014). Data completeness refers to the availability of SC management data in the company's data repository, while completeness refers to data that is missing or intact (Kwon et al., 2014). With improved data quality, businesses will feel more comfortable using BDA in their daily operations.

Organisational Context

Previous studies have identified various characteristics and properties that influence the adoption of information technology at the organisational level, including the **top management support, IT infrastructure and capabilities and financial readiness (**Hsu et al., 2014; Maduku et al., 2016; Wamba et al., 2016). TM support refers to top management's appreciation of information technology function and participation in information technology activities. Organisational readiness refers to TM support, IT infrastructure and capabilities, and financial readiness of the adopting organisation. TMs contribute to the creation of a favourable environment and the provision of sufficient resources to accelerate the adoption of IT innovations. Thus, the degree of TM support for BDA technology has a direct impact on how an organisation communicates and adopts BDA for logistical improvement. IT infrastructure and capabilities are both material (physical assets) and immaterial (human resources, skills, and experience) assets. Studies indicate that the greater a company's IT capabilities, the more likely it is to adopt innovative technology (Kamal, 2006). Thus, the IT infrastructure and capabilities of a business may influence its likelihood of adopting BDA. Financial readiness is a significant predictor of an organisation's acceptance of technological innovation. Without adequate financial support, businesses cannot afford IT equipment or professional BDA personnel (Maduku et al., 2016). BDA's initial and ongoing costs require a significant amount of financial capital. Moreover, firms with sufficient capital can better withstand disruptions caused by the adoption of modern technologies (Sila, 2013).

Environmental Context

The environmental refers to the climate in which an organisation operates (Maduku et al., 2016). **Governmental support, competitive pressure from trading partners, competitors, and regulators, and consumer readiness** refer to the environmental aspects of our model (Sharma et al., 2007). Contextual factors can act as both facilitators and inhibitors when determining whether or not to adopt a new information technology. While government support is necessary for the spread and adoption of information technology, Hsu et al. (2014) found that firms facing greater external pressure from trading partners, competitors, and regulators were more likely to adopt innovations. Studies have shown that regulatory environment influences innovation diffusion (Zhu et al., 2006). If a company desires government assistance, it must adopt innovative technologies (Hsu et al., 2014). Government regulations, according to Zhu and Kraemer (2005), stifle IT adoption. Lastly, consumer readiness will also impact innovation adoption as some consumers may not be ready to shift to modern innovations, and stick to their original routines, and thus consumer readiness can also stifle IT adoption or in this case BDA adoption for logistical improvement.

2.5 SC and Logistics Traits

SC characteristics must be considered because the purpose of this study is to evaluate firm intent to utilise BDA for retail firms. **Information sharing** is one important aspect as this is the extent to which firms share relevant, complete, and confidential information with their SC partners in a timely manner. As the basis of SC collaboration (Lee and Whang, 2000), information sharing is regarded as a unique asset that can enhance organisational capabilities (Brandon-Jones et al., 2014). Information sharing contributes to information flow integration, a critical factor in the integration of SC processes (information, physical, and financial flow integration) (Rai et al., 2006). Given the intangible nature of information sharing (Brandon-Jones et al., 2014), the maturity of an organization's information technology infrastructure or information systems (**IT maturity**) dictates how effectively information is communicated and distributed. Understanding the formation of SC information sharing typically involves a focus on the role of SC connectivity. **Connectivity** refers to the capacity of collect, analyse, and disseminate the data necessary to synchronise decision-making across value-added activities using information technologies (Fawcett *et al.*, 2011; Mangla *et al.*, 2020). Hence, connectivity enables SC participants to exchange messages, upload or download data, and work globally together.

2.6 BDA applications in logistics

The new generation of logistics features short chains, smartness, resilience, and transparency (Delafenestre, 2019). This has influenced the direction of research as evidenced in the literature around this topic. Prior research on BDA applications in logistics has focused on the socio-technical aspects – specifically, pre-adoption intentions, benefits, or potential barriers – rather than the post-adoption attributes or behaviour, producing perceptions with unit of analysis being at the individual level (Angappa *et al.*, 2017; Papadopoulos *et al.*, 2017). There is a low research interest on the post-adoption BDA applications that, for instance, discuss the extent to which BDA is accepted, implemented or is "diffusing" across the supply chain (Maheshwari, Gautam and Jaggi, 2021). The current literature in BDA applications in logistics (refer to Table 1) has identified key enablers of BDA implementation, for instance, top management support (Jaouadi, 2022), organisational willingness (Alaskar, Mezghani and Alsadi, 2021), resource dedication, financial support for big data initiatives, big data/data science skills, organizational structure and change management program (Lamba and Singh, 2018). BDA can be applied in logistics to realise benefits, including competitive advantage, value creation and enhancing resilience (Wamba *et al.*, 2018; Seyedan and Mafakheri, 2020).

Table 1 – Summary studies of BDA applications in logistics

Source	**Area/Unit of Analysis**	**Identified dimensions/BDA capabilities**
Lamba and Singh (2018)	Supply chain operations / Individual	Big data quality management, data capturing and storage, security/privacy, data integration, top management commitment, financial support, data analytics skills, alignment with bid data strategies
Wamba et al., (2017)	Individual	BDA capabilities, infrastructure capability, BDA personnel capability, process-oriented dynamic capabilities.
Gunasekaran et al., (2017)	Supply chain performance and organisational performance / individual UoA	Top management commitment, connectivity, information sharing, BDA acceptance, assimilation, supply chain performance, organisational performance.
Gupta et al., (2020)	Individual	Big data/data science skills, tracking and localization of products, appropriate and feasibility study for aiding the selection and adoption of big data technologies and techniques.
(Jaouadi, 2022)	Individual	Big data analytic capability, big data analytic staff capability, employee development, employee empowerment and employee involvement
Alaskar, Mezghani and Alsadi, (2021)	Individual	Compatibility, relative advantage, and top management support.

The predominant views in extant literature are either deterministic (BDA implementation results in particular outcomes) or contingency (where the interaction between situational factors results in specific outcomes) perspectives for the understanding of given outcomes for organisations. Although many studies have considered the short-term impact or potential evaluation of BDA in logistics and supply chains, there is a scant literature focusing on the long-term analysis and focusing on the outbound logistics function in retail supply chains. We argue that gaining insight into the process by which BDA can be established as well as its potential impact – considering the organisational, technological, and social/environmental changes – can enable in-depth theoretical insight realisation about how BDA applications in logistics and supply chain management within organisations develops.

2.7 BDA and outbound retail logistics

The application of BDA in outbound retail logistics has become increasingly prevalent in recent years, with businesses collecting and analysing large volumes of data to enhance the efficiency and effectiveness of their operations (Gopal *et al.*, 2022). BDA applications in retail logistics management incorporates a diverse range of applications and statistical analytical measures, which have continued to evolve with the proliferation of technology – specifically AI and machine learning. However, the use of big data analytics in this context is not without controversy, and there is a growing debate about its potential benefits if it is indeed living up to the hype as a technology.

Proponents of BDA argue that this technology offers significant benefits when applied within outbound retail logistics, including the ability to make more informed and data-driven decisions (Vassakis, Petrakis and Kopanakis, 2018), improve supply chain efficiency (Xiang *et al.*, 2021; Kumar, Shrivastav and Bhattacharyya, 2022), and enhance customer satisfaction (Akter and Wamba, 2016; Wamba *et al.*, 2017). For example, Govindan et al., (2018) argue that by analysing data from sales, supply chain, and customer interactions, businesses can identify trends and patterns that can help them optimize their operations and better meet the needs of their customers. Additionally, big data analytics can be used to identify inefficiencies and bottlenecks in the supply chain, allowing businesses to adjust and improve their overall performance. There is an increasing prevalence of studies showcasing the benefit of BDA in logistics management. For example, Singh, Shukla, and Mishra (2018) developed a BDA approach for analysing Twitter data to identify problems with supply chain and logistics management of food products. Furthermore, scholars have also examined the role of BDA in enhancing logistics activities, for instance Moldabekova *et al.*, (2021), where the authors present statistical analysis that can improve logistics performance in supply chains, or Yu *et al.*, (2021), where a quantitative research study validates the impact of big data analytics capability (BDAC) in developing hospital supply chain integration (SCI) and operational flexibility. Besides, the use of big data analytics in outbound retail logistics allows companies to gather and analyse vast amounts of data in real-time, providing valuable insights into supply chain and logistics operations (Lai, Sun and Ren, 2018). This can enable companies to identify bottlenecks and inefficiencies, as well as forecast demand and optimize routes and schedules. By leveraging these insights, companies can improve the efficiency and effectiveness of their supply chain and logistics operations, leading to cost savings and reduced environmental impacts (Angappa *et al.*, 2017; Wamba *et al.*, 2017). Additionally, the use of big data analytics can enable companies to provide more personalised and timely services to customers, enhancing their satisfaction and loyalty (Akter and Wamba, 2016).

On the other hand, critics have raised concerns about the negative impacts of relying on big data analytics in outbound retail logistics, for instance, Yu et al., (2021) raises concerns relating to privacy and data security. With the increasing amount of data being collected and processed, there is a risk of sensitive information being exposed or misused. This could have negative consequences for both individuals and companies and could undermine trust in the use of big data analytics in outbound retail logistics. Besides, BDA applications can overly complicate and obscure supply chain and logistics operations (Gopal *et al.*, 2022). With the reliance on algorithms and machine learning, it can be difficult to understand the underlying decision-making processes and to identify potential biases or errors.

3. Methodology

This study employed a multiple holistic case study of a UK retailer and builds on the constructivist methodology, as well as our TOE approach (Flyvbjerg, 2013; Yin, 2018).

Our case study was chosen to develop theory for an existing problem situation and aligns with our TOE approach, that is, to provide a comprehensive understanding of the importance of implementing BDA in logistics supply chain operations, and thus served as an appropriate contextual premise to conduct a study. Furthermore, our study focused on examining fifteen concepts, including compatibility, relative advantage, and complexity, all of which were derived from numerous studies: top management support, organisational readiness, IT infrastructure and capabilities, financial readiness, government support, competitive pressure from trading partners, competitors, and regulators, consumer readiness, BDA, and SC. The semi-structured interview questions allowed participants more freedom to engage in a broader discussion and provide richer information beyond the confines of the questions posed.

Table 2: Sampled Participants

Participant Code	Years of Experience	Interview Duration
SM1	4	44mins
SM2	8	52mins
SM3	2	56mins
SM4	9	39mins
SM5	4	37mins
SM6	6	43mins
SM7	8	50mins
SM8	2	52mins
SM9	5	59mins
SM10	7	41mins
SM11	9	46mins
SM12	3	56mins
SM13	10	55mins
SM14	4	36mins
SM15	12	58mins

We gathered information from semi-structured interviews conducted at some of the leading retailers in the UK. Given that they are easily accessible and reputable businesses willing to participate in interviews, British retailers were selected. A convenience sample of fifteen (15) supply managers was interviewed for this study. The choice of sample size of fifteen was to allow us to gain in-depth insights into the challenges and potential benefits of using big data analytics in this context. Therefore, the insights from the industry experts allows the provision of a more comprehensive and nuanced analysis, which can inform the development of effective strategies for the adoption and use of big data analytics in outbound logistics operations. Table 2 shows the detailed sample characteristics. The rationale for the sample size is based on the recommendation of Creswell and Creswell (2018) who claim that a suitable number of interviews for each case is 15-30. The interviews took an average of 45 minutes to conduct with some lasting as little as 30 minutes and up to 1 hour. The duration of the interviews is summarised in Table 2, while Table 3 summarises the supplementary data analysed to support the empirical study.

Table 3*: Summary of Documentation*

No.	Code	Description

UK Retailers		
Doc1	D1	Company policy
Doc2	D2	ICT policy
Doc3	D3	Annual reports

The interviews were conducted using video conferencing tools such as Zoom, Skype and Go-to-Meeting. The interviews were captured by directly contacting the retailers via email. Data collected through interviews were analysed qualitatively using thematic analysis. This method was adopted as it is the most common qualitative approach used for analysing interview data and helps to gain a more in-depth perspective or opinions about the topic under examination (Fugard & Potts, 2015). Themes were developed and coded using a software tool known as NVivo (see Figure 3), following an inductive data analysis process as data was being collected and collated. The key themes and sub themes presented in our findings are summarised in Table 3.

Adopting the technology-organisational-environmental (TOE) as a theoretical foundation in information systems (IS) research is widespread and we believe it is helpful for conducting research on big data analytics in outbound retail logistics. The TOE framework is grounded in the Diffusion of Innovation (DOI) and the institutional theory (Sun *et al.*, 2018). The framework allows researchers to consider the interplay between the technology (i.e., big data analytics), the organizational factors (e.g., management support, organizational culture), and the external environmental factors (e.g., government regulations, market competition) that can influence the successful implementation of big data analytics in this industry. The benefit of adopting the TOE framework in this current study enables a more comprehensive understanding of the factors that drive the adoption and impact of big data analytics in outbound retail logistics. This, in turn, can inform the development of effective strategies and policies for the successful implementation and integration of big data analytics in this field.

4. Results & Discussion

In this research, we used NVivo to conduct the analysis. The study adopted thematic analysis to organise and code the key themes of our analysis to present coherent and well-structured findings. Our research objective is to assess whether the concepts suggested in the TOE framework are effective in understanding the adoption of BDA for logistical improvement. The process of data analysis comprised of taking the concepts and categorising them under the first order themes. The themes were based on the key components of the TOE model, namely technological, organisational, and environmental contexts of BD adoption for SC; Technology Support for SC Adoption, Organisational Drivers & Barriers of SC supported IT and Environmental Influences of IT supported SC. Lastly, for ethical reasons, the participants real identities have been anonymised and are therefore represented as a pseudonym (e.g., supply manager 1 will be SM1). Since many of the participants had no prior knowledge of BDA, the term was first explained to them.

4.1 Technology Support for SC Adoption

With respect to the **perceived benefits** of technology adoption or BDA for SC logistics, the participants mentioned several key benefits:

The participants identified "**radicalising process change**" as a perceived benefit of BDA adoption for SC, stating:

> *To simplify and optimise supply chains, it should be possible to radicalise process change through examining all components of each process and link supply chain in granular detail. To ensure our goods are produced and distributed efficiently, I believe data analytics could help us accurately determine everyone's activities and tasks through timely and accurate data analysis of each part of the supply chain and logistical process. [SM1]*

Similarly, "**bolstering supply chain efficiency**" was another perceived benefit:

> *I believe BDA could help us find bottlenecks and find out which processes and components are not working as well as they should. This is because in the past, businesses only made and delivered products for a small group of customers. BDA could be used to predict customer needs and tastes accurately and quickly for customised products. It could then be used to make a more efficient SC and logistics model. [SM4]*

Several other participants mentioned that early identification of problems affecting logistics was another perceived benefit, stating that the use of predictive analytics could help with the "**early identification of logistical system flaws**," which in turn could save money, time, and the hassle of redistributing products due to logistical errors [SM1-3, SM5-9].

Based on the benefits that BDA and adopt intention have provided thus far, their perceived benefits are positive. Before implementing an innovative technology on a large scale, businesses must evaluate its practical benefits or advantages considering the intensifying competition among companies (Rahi *et al.*, 2021). Firms' willingness to adopt modern technology innovations and their perception of benefit can be confirmed previous literature (Sharma and Citurs, 2005; Ramdani, Kawalek and Lorenzo, 2009; Tsai *et al.*, 2015; Maduku, Mpinganjira and Duh, 2016; Nisar *et al.*, 2020). So, our findings and the literature point to importance of perceived benefits of integrating BDA into the logistics system through businesses' cautious adoptive decisions of technologies like predictive analytics into their logistical strategies.

In terms of **technological complexity**, the participants stated that "**cultural resistance of BDA technology**" is a challenge as it may be difficult to adapt to BDA immediately due to their unfamiliarity with this modern technology, and that some of their colleagues may resist adopting BDA [SM1-5, SM7, SM10-15]:

> *Because I am unfamiliar with BDA, adapting to the technology may be difficult for me. Based on your explanation, I am aware of the potential benefits BDA could bring to our company. However, the transition phase could be lengthy, thereby jeopardising the early benefits of integrating BDA into our supply chains and logistics networks. [SM10]*

The complexity of the technology and the desire to implement BDA may be viewed negatively. Participant perspectives on adopting BDA may not be influenced by technology, as they may already possess some of the most innovative technologies (data mining, data visualization, and data analytics). Strategic outsourcing is an option in addition to the fact that technology is no longer the only way to gain access to new IT innovations. Due to the availability of suitable technology and the openness of the BD market, technological barriers no longer play a significant role in retaining competitive advantages in the BD era. Furthermore, "**technophobia**" persists, with employees fearing that technology will replace them or refusing to use it because they are accustomed to more conventional methods of work.

With respect to **data quality**, the participants mostly focused on the "**accessibility, consistency and completeness of BD**" for effective BDA in supply chains and logistics networks [SM1-3, SM6, SM9, SM12-15]:

> *If I were to implement BDA to establish efficient supply chains and logistics networks, the data used to enhance these systems would have to be clean, universally accessible, accurate, and comprehensive. One piece of inaccurate or incomplete data could jeopardise the accuracy of the information we receive to improve our supply chain and logistics networks; depending on the outcome, this could either save us time and money or cause us to lose it. This is therefore a make-or-break situation which many of my colleagues may not want to risk given the uncertainty involved. [SM13]*

Literature suggests that businesses with high-quality data are more likely to adopt BDA, but our findings do not support this claim. To illustrate this, consider how traditional operations/SC and logistics management focuses solely on the physical and monetary flows of SC integration while ignoring the significance of information flow (Rai and others, 2006). As a result, exchanges between SC partners are primarily focused on time rather than quality, as they fail to recognise the significance of, among other things, "**Uniform terminology, unbiased data input, and open data sharing.**" Despite the uncertainty surrounding BDA's integration of modern technologies, people will always have a predisposition toward a technology, resulting in a lack of trust in it. The phenomenon of cultural resistance to change has consistently been identified as a barrier to the successful implementation of new technologies within organisations. This resistance can be attributed to the inherent difficulty in altering deeply ingrained human behaviours and attitudes. As such, addressing cultural resistance must be a strategic consideration for organisations seeking to effectively adopt new technologies. While some strategies, such as effective communication and training, may mitigate the impact of cultural resistance, it remains a persistent challenge that must be actively managed in order to ensure the success of technology adoption initiatives.

4.2 Organisational Drivers & Barriers of SC supported IT

In terms of **TM support**, the participants' comments mostly stemmed from their participation in IT activities [SM1-3, SM6, SM9-15]:

> *I am a huge fan of modern technologies and innovations, but I cannot always rely on them, which explains why I do not participate in many IT-related endeavours. You have explained to me what BDA is and how*

it can promote efficiency and so on, but I need to see more real-world examples of it in action to be convinced to use it. I apply this model to all technologies I employ. Initially, I did not trust smartphones due to their potential security flaw, but I am now aware that they are effective devices capable of performing tasks that a personal computer can. Before I can therefore fully support the technology, I require additional background information and context. [SM15]

Another participant stated top management support for technologies like BDA could be an attractive prospect for the company since many companies today are under the **industry 4.0 umbrella** [SM4-5, SM8]:

Being a part of the industry 4.0 movement is an effective way to bring the company into the 21st century and streamline our SC and logistics networks to increase profits in the long-term, but top management support needs to be strong in order to achieve this. I am aware that many of my colleagues will not share the same vision as me. [SM5]

Given the contradictory opinions of participants and the lack of trust exhibited by some, but not all the participants, it is difficult to predict the likelihood of BDA adoption from TM support. If TM understands the benefits that BDA can bring to SC and logistical networks, they are willing to help develop the company's BD capability, which is comprised of "**BDA infrastructure flexibility, BD management capabilities, and BDA personnel expertise capability"** (Garmaki, Boughzala and Wamba, 2016). Several studies have demonstrated that firms' IT adoption has a substantial effect on this notion (Maduku et al., 2016; Hsu et al., 2014), but there are still trust issues among top managers involved in SC and logistics. The complexity of adopting BDA can create a divide between managers, resulting in a lack of trust in technologies that are unfamiliar or not of personal interest. This speaks to the ongoing issue of individual predispositions towards technology, which can persist as a hindrance to successful adoption. So again, individual predispositions towards technology will always be an issue because, as stated before, the complexity of BDA adoption will create a rift between managers, making them not trust technology they are not familiar with or interested in.

With respect to **IT infrastructure and capabilities**, the participants discussed about their "**reliance of human and material assets**," namely their existing physical assets and human resources required to adopt BDA [SM1-5, SM8, SM10-15]:

Although we have the physical assets, such as computers, machinery, and vehicles, to perform our daily supply chain and logistical processes, we lack the human resources to streamline these processes, not due to incompetent or inept personnel, but due to their aversion to modern technologies and innovations. Training is not a problem, but personal bias and technophobia significantly impede the development and adoption of modern technologies. [SM8]

Our finding show that IT infrastructure and capabilities did not play a role in the decision to use BDA. Using strategic outsourcing to solve technological or professional issues is possible for businesses, and this may be the case with regards to technology complexity.

Even organisations with inadequate IT infrastructure can adopt BD with the assistance of external forces. BD's unfamiliarity with corporations may also contribute to this unexpected result. Those who are not up to date on the latest IT trends (Maduku et al., 2016) maybe "**unaware of the tangible and intangible resources**" required to use BDA when it comes to the latest data-driven IT technology, and so will reject the technology based on their lack of understanding; this has been observed as the route cause of technophobia as managers are not willing to confide in technology.

With respect to **financial readiness**, the participants tied this with their organisation's acceptance of technological innovation [SM1-2, SM3-5, SM12-15]:

> *I have previously mentioned how some of my co-workers are hesitant to adopt technologies such as BDA, but based on experience, our financial preparedness is also tied to our innovation adoption readiness. Investing in innovations such as BD could be a costly endeavour because, as you mentioned, we may need to develop a new IT infrastructure and invest in data warehouses for this to be worthwhile. We will invest if we believe the potential benefits to our SM and logistics network make the risk worthwhile, but my colleagues may be hesitant because there is so much to lose as well as gain. [SM11]*

Similar to Maduku et al., (2016), who found that financial resources had no effect on the adoption of mobile marketing, this study did not find a clear connection between financial preparedness and BDA adoption. This could be because we received most of our responses from SM managers with "**little to no experience with BDA**" so it is likely that they underestimated the value associated with implementing modern technologies like BDA and "**overestimated the financial risk**" of adopting said technologies because they did not fully understand and appreciate its value in SC logistics management, and thus presents a significant barrier to BDA adoption from a management perspective.

4.3 Environmental Influences of IT supported SC

In terms of **macro influences**, the participants stated that they have received "**very little support from government**" regarding the adoption of technologies to streamline their supply chains and logistics networks [SM1-5, SM9, SM11-15]:

> *I believe governments could do more to promote technological innovation adoption as good government public relations could help some of our more reluctant colleagues to adopt new innovations like BDA. [SM9]*

With respect to "**external pressure from trading partners, competitors, and regulators,**" the participants felt that government regulation may impede IT adoption [SM3-5, SM7, SM13, SM15]:

> *I think we will get to a point where government regulation may further decrease our willingness to adopt modern technologies as certain restrictions may be imposed how we could use BD to improve our logistical system and supply chains. We may not be able to use certain datasets need to support our systems, thus limiting what we can do with*

> *the technology. This could be stifling to our overall business performance. [SM3]*

With respect to **consumer readiness**, the participants mentioned that like their colleagues, their consumers may also agree with them, thus "**stifling IT adoption**" [SM3-5, SM7, SM13, SM15]:

> *Like my co-workers, consumers may be unwilling to adopt modern innovations and prefer to stick to their original routines; accordingly, consumer readiness can impede IT adoption or, in this instance, BDA adoption for logistical enhancement. This may set out company back a few years and run the risk of being left behind as other companies embrace modern innovations. [SM5]*

Overall, macro influences have a significant impact on IT adoption. Government efforts in public relations may have a positive effect on TM support and adoption intent. So, executives are more likely to respond to official PR calls because they are more concerned with the government orientation of their company. If the regulatory environment is favourable, the direct impact of TM on BDA adoption will be enhanced. In addition, "**competitive pressure**" and the complexity of the technology would influence adoption. Businesses are urged to adopt BDA, regardless of how challenging it may be, if their competitors are doing so. Complexity is no longer as crucial as keeping up with the competition.

Lastly, the **maturity of an organisation's information technology infrastructure** or information systems was extensively discussed, but information sharing was not mentioned. Participants stated that their company's reluctance to adopt BDA was due to technophobia and financial unreadiness. Participants have cited technophobia and reluctance to train in BDA as barriers to adoption. However, the ability to collect, analyse, and disseminate data was cited as an important aspect of connectivity in the context of synchronising decision-making across value-added activities. Using connectivity, SC participants can exchange messages, upload data, and collaborate on a global scale; however, this cannot be accomplished without the cooperation of other parties.

4.4 Key Takeaways

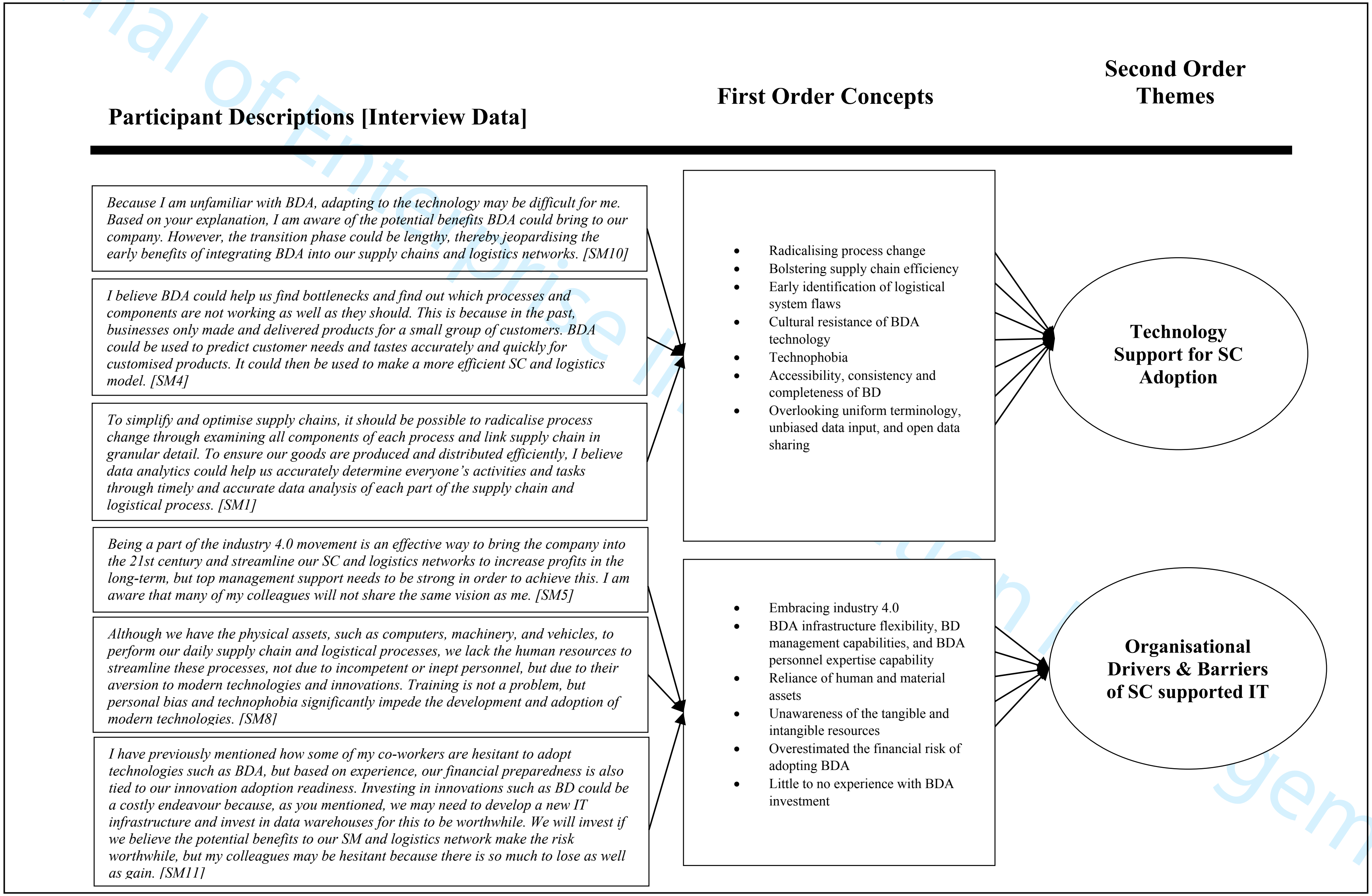
On reflection to the above findings and discussion, we highlight the most significant discoveries:

1. BDA adoption and usage facilitators and barriers have been identified
2. Contextual concepts parallel to previous literature have been seen as moderators in facilitating our comprehension of how environmental changes impact BDA decision-making.
3. Effects of SC and logistical connectivity on BDA utilisation have been identified by contrasting SC maturity levels, and a connected SC makes data more accessible and the exchange of information easier.
4. Perceived benefits of BDAs influence adoption.
5. Instead of investing in IT infrastructure, capabilities, and technology complexity, businesses can focus on their core business activities by outsourcing complex areas to experts.

Table 4: First Order Concepts & Second Order Themes

Second Order Themes	First Order Concepts
Technology Support for SC Adoption (Technology)	**Perceived Benefits** • Radicalising process change • Bolstering supply chain efficiency • Early identification of logistical system flaws **Technological complexity** • Cultural resistance of BDA technology • Technophobia **Data quality** • Accessibility, consistency, and completeness of BD • Overlooking uniform terminology, unbiased data input, and open data sharing
Organisational Drivers & Barriers of SC supported IT (Organisational)	**Top management support** • Embracing industry 4.0 • BDA infrastructure flexibility, BD management capabilities, and BDA personnel expertise capability **Company IT infrastructure and capabilities** • Reliance of human and material assets • Unawareness of the tangible and intangible resources **Financial Readiness** • Overestimated the financial risk of adopting BDA • Little to no experience with BDA investment

Environmental Influences of IT supported SC (Environmental)	**Macro influences** • Limited government support • External pressure from trading partners, competitors, and regulators • Competitive pressure • Consumer readiness • Maturity of an organisation's information technology infrastructure


Participant Descriptions [Interview Data]
First Order Concepts
Second Order Themes
Because I am unfamiliar with BDA, adapting to the technology may be difficult for me. Based on your explanation, I am aware of the potential benefits BDA could bring to our company. However, the transition phase could be lengthy, thereby jeopardising the early benefits of integrating BDA into our supply chains and logistics networks. [SM10]
I believe BDA could help us find bottlenecks and find out which processes and components are not working as well as they should. This is because in the past, businesses only made and delivered products for a small group of customers. BDA could be used to predict customer needs and tastes accurately and quickly for customised products. It could then be used to make a more efficient SC and logistics model. [SM4]
To simplify and optimise supply chains, it should be possible to radicalise process change through examining all components of each process and link supply chain in granular detail. To ensure our goods are produced and distributed efficiently, I believe data analytics could help us accurately determine everyone's activities and tasks through timely and accurate data analysis of each part of the supply chain and logistical process. [SM1]
Being a part of the industry 4.0 movement is an effective way to bring the company into the 21st century and streamline our SC and logistics networks to increase profits in the long-term, but top management support needs to be strong in order to achieve this. I am aware that many of my colleagues will not share the same vision as me. [SM5]
Although we have the physical assets, such as computers, machinery, and vehicles, to perform our daily supply chain and logistical processes, we lack the human resources to streamline these processes, not due to incompetent or inept personnel, but due to their aversion to modern technologies and innovations. Training is not a problem, but personal bias and technophobia significantly impede the development and adoption of modern technologies. [SM8]
I have previously mentioned how some of my co-workers are hesitant to adopt technologies such as BDA, but based on experience, our financial preparedness is also tied to our innovation adoption readiness. Investing in innovations such as BD could be a costly endeavour because, as you mentioned, we may need to develop a new IT infrastructure and invest in data warehouses for this to be worthwhile. We will invest if we believe the potential benefits to our SM and logistics network make the risk worthwhile, but my colleagues may be hesitant because there is so much to lose as well as gain. [SM11]
• Radicalising process change
• Bolstering supply chain efficiency
• Early identification of logistical system flaws
• Cultural resistance of BDA technology
• Technophobia
• Accessibility, consistency and completeness of BD
• Overlooking uniform terminology, unbiased data input, and open data sharing
• Embracing industry 4.0
• BDA infrastructure flexibility, BD management capabilities, and BDA personnel expertise capability
• Reliance of human and material assets
• Unawareness of the tangible and intangible resources
• Overestimated the financial risk of adopting BDA
• Little to no experience with BDA investment
Technology Support for SC Adoption
Organisational Drivers & Barriers of SC supported IT

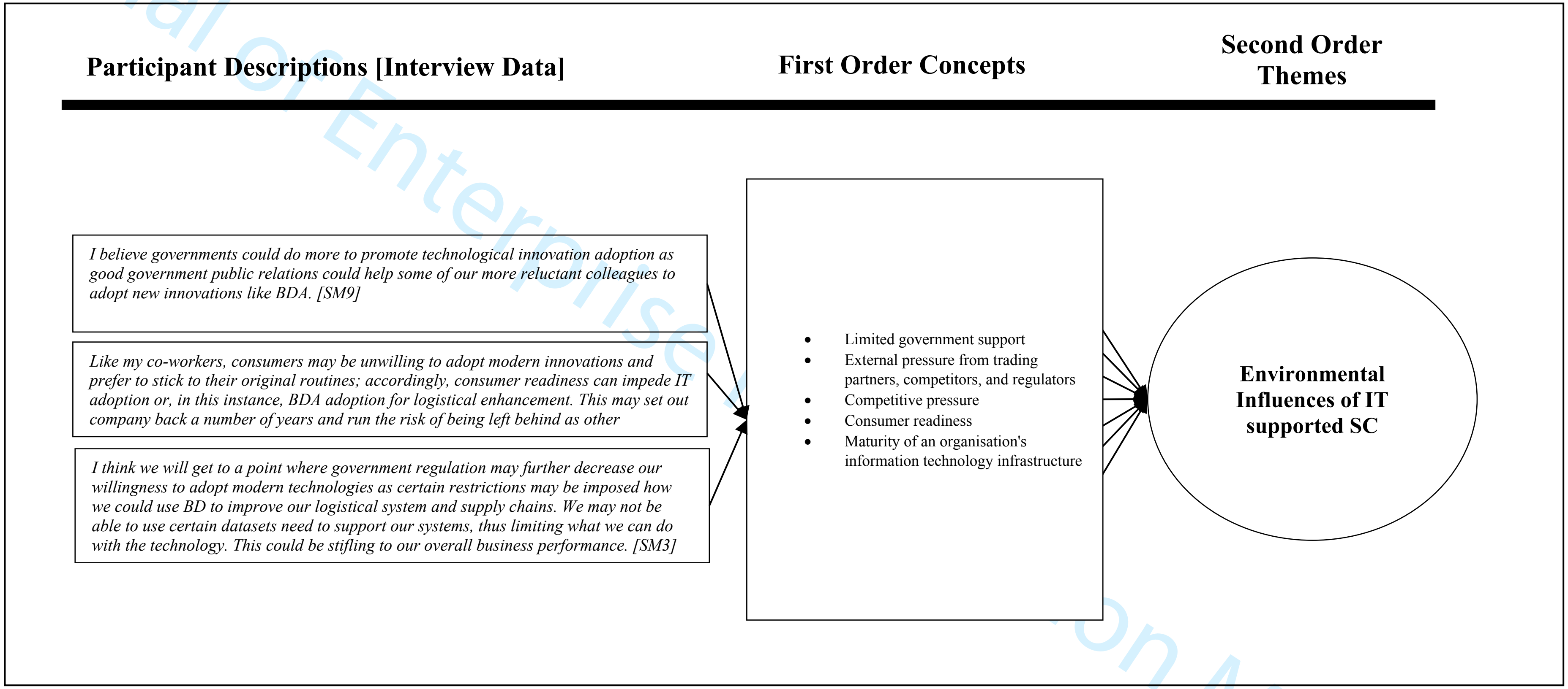


Figure 2: *Coding & Sample Data*

5. Conclusion

The perceived benefits of using BDA are the strongest predictor among technological, organisational, and environmental factors, followed by TM support. If the new analysis technology is truly advantageous to SC and logistical management, for instance, companies do not require an advanced IT infrastructure or financial readiness.

5.1 Study contributions

The study is beneficial for both researchers and practitioners. This is the first empirical investigation of BDA adoption we have encountered, particularly in supply chain and logistics management. This paper focuses on identifying potential facilitators and barriers to BDA adoption and utilisation. Contrary to previous research, we view contextual concepts as moderators that can help us understand how environmental changes affect BDA decision-making. We were able to determine the impact of SC and logistical connectivity on BDA utilisation by comparing SC maturity levels. Consequently, a well-connected SC facilitates the exchange of information and the accessibility of data. Lastly, our findings on the adoption of IT innovation differ from those of previous studies. The adoption of BDAs is driven by the perception of their benefits. Companies appreciate BD's ability to provide a competitive advantage. By outsourcing unfamiliar fields to experts rather than investing in IT infrastructure and capabilities and technology complexity, businesses can concentrate on their core business activities. Research on the adoption of IT innovations is novel for BD studies. Thus, our research on the adoption of BDAs contributes to the body of knowledge on the subject.

5.2 Theoretical, practical and managerial implications

Our study has made theoretical contributions by extending the TOE framework in the field of operations and supply chain management. Furthermore, our study has provided insights into the challenges and potential benefits of applying BDA in outbound logistics operations in the retail industry. We argue that this is an area that has received relatively little attention in the literature, and our study adds to the existing knowledge by presenting empirical insight from the application of BDA in this specific context. By drawing on insights from subject matter experts, our study provides practical perceptions and recommendations for organisations considering the implementation of BDA in outbound retail logistical operations. Secondly, our study has explored the role of the TOE framework in supporting the integration and analysis of BDA in retail outbound logistics operations. This is an important contribution, as the use BDA in logistics is relatively new and rapidly evolving as a research field. By examining the interplay between technology, organisational structure, and environmental factors, our study provides insights into the ways in which the TOE framework can support the implementation and adoption of BDA in retail logistics operations. This can inform the development of effective strategies for organisations seeking to apply BDA in this context. Thirdly, our study has considered the potential impact of big data analytics on outbound logistics operations in the retail industry. This is a critical issue, as the use of big data analytics has the potential to transform the way organisations operate. By examining the potential benefits and challenges of using BDA in outbound logistics, our study provides insights into the ways in which this technology can support organisational performance and enhance competitiveness. This can inform the development of effective strategies for the adoption and use of big data analytics in outbound logistics operations.

In addition to its theoretical contributions, this study has practical implications for organisations, both business intelligence (BI) adopters and BI service providers. Companies on the fence about adopting this new data analysis technology should consider the benefits that BDA can bring to SC and logistics management, as well as the organisation, according to researchers. The alignment of a company's analytics capability with its business strategy can influence the post-implementation perception of BDA. In addition to improving customer satisfaction, BD service providers should educate the organization's upper management on the benefits of BDA. According to this study, TM support is the most important organisational factor in determining whether BDA is adopted. According to our research, cross-functional departments must collaborate when a company adopts innovative technology. Adoption decisions are frequently influenced by IT-related responses that do not take financial considerations into account. BDA should not only attract the attention of TM but also be utilised by other departments to generate business value.

This study has significant implications for both researchers and practitioners, but it is important to note a few limitations. Given that BDA is still a novel concept in supply chain and logistics management, organisations may hold differing opinions regarding the business benefits BDA can bring to supply chain and logistics management. This may influence the validity and reliability of the study. For starters, many of our interviews were conducted with SM managers who had little or no knowledge of BDA, which can be problematic because individual SM managers' decisions or perceptions of innovative technology may not accurately represent the company's perspective. This may explain why there is no correlation between financial readiness and adoption intent. It is possible to circumvent this issue by conducting a long-term study of BDA attitudes. The protection of sensitive data is a major concern in the post-BD era. If a company mines data from third parties, its own data may be exposed. Data security and the creation of industry standards could be the subjects of future research. A secure BD environment may increase the desire for BDA adoption. In addition, the benefits of technology were viewed as a whole, without regard to what companies valued most. Future research could therefore categorise diverse benefits to determine the most significant benefit. We believe that additional factors may influence the adoption decision. In the future, in addition to the TOE driver, we intend to consider additional context-related factors. Factors such as the size of the SC and the complexity of the delivery system, which necessitate the integration of a larger volume of data or information, may influence the decision-making process.

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